Kaon Studies:
K Identification & Beam Flux

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I. Data Summary

Set A: K^- Beam Runs Target Full (Runs 138, 140, 141,143)

Reactions Studied:

$K^- p \longrightarrow \Lambda\ \pi^0 \longrightarrow (n\,\pi^0)\,\pi^0 \longrightarrow n + 4\,\gamma$ (1)

$K^- p \longrightarrow \Sigma^0 \pi^0$
$\longrightarrow (\Lambda\,\gamma)\,\pi^0 \longrightarrow (n\,\pi^0)\,\gamma\pi^0 \longrightarrow n + 5\,\gamma$ (2)

$K^- p \longrightarrow K^0\ n \longrightarrow (\pi^0\pi^0)\,n \longrightarrow n + 4\,\gamma$ (3)

Set B: π^- Beam Run -- Target Full: Run 50

Dominate Background:
$\pi^- p \longrightarrow n\,\pi^0 \longrightarrow n + 2\,\gamma$ (4)

C: Other Studies:

Target Empty K^- Beam Run (Run 142)
- No surprises -- not discussed herein

K^- Beam Runs Target Full, but Time-of-Flight Off
- K^- ‘s not observed

WORM Rejection: Backward Direction θ_{CUT} Dependence

- $\theta_{CUT} = 130^0$ or 120^0 Both reject **WORMS**

II. Code/Calibration

- CB Analyzer
- User code (cb_kaon) to implement cuts and histogram
- Calibration Method of S. Stanislaus

III. Time-of-Flight (TOF) Histograms

TOF Using Scalars S1 & ST ($t_{TOF} = T_{S1} - T_{ST}$)

A. K^- Runs (Data Set A)

(i): All Events for Call to User Code

(ii) Cuts: $\theta > 130^0$
No cluster with E > 20 MeV
x_beam & y_beam > 4.0 cm at z = 0

(iii) Cuts: Above Cuts
Outside of K_{TOF} Window

[K_{TOF} Window: -5.5 ns < t_{TOF} < -4.0 ns]

B. π Runs

(i): All Events for Call to User Code

(ii) Cuts: $\theta > 130^0$
At least 1 cluster with E > 20 MeV
x_beam & y_beam OK at z = 0

(iii) Cuts: Above and
$T_{TOF} < -6.0$ ns (π_{TOF} Window)

- Note Ratio $R_{\pi,K}$ = (# π 's/# K's) = ~ **50**

IV. Two Cluster Invariant Mass Distributions

A. For K^- Beam Runs (Set A) {Fig. 1a}

B. For π^- Beam Runs (Set B) {Fig. 1b}

- π peak in both sets
- π peak washed out if no θ_{CUT}

V. π^0 Missing Mass Distributions

A. For K^- Beam Runs (Set A) {Fig. 2a}

B. For $\underline{\pi^-}$ Beam Runs (Set B) {Fig. 2b}
Analyzed as though they were $\underline{K^-}$'s

- Peak at Λ mass
- Shoulder at Σ^- mass (? perhaps)
- But note that π's (analyzed as K^-) produce MM at Λ !!

$\therefore \exists$ Possibility of contamination from π^- reaction!

- Is TOF region π^- free?
How Can we measure contamination?

VI. π^0 Frequency Distributions with Cut on Λ or Σ^0 Missing Mass Window

A. For K^- Beam Runs --Λ & Σ^0 Windows {Fig. 3a, b}

B. For π^- Beam Runs {Fig. 3 c, d}
(Analyzed as though they were K^-'s)

- Extremely few two - π clusters with π^- Beam.
- Suggests cut to Select K^- over π^- reaction
- Gain by factor of ~100

C. Number of Clusters for Above Shown in Fig. 3 e-h

VII. Neutron Signal: Select Events within Λ Missing Mass Window ($M_\Lambda \pm 36$ MeV)

Calculate Missing Mass off two π^o Invariant Mass

A. For K^- Beam Runs {Fig. 4a}

B. For π^- Beam Runs {Fig. 4b}

- Neutrons Evident in Missing Mass
  in both π^- & K reactions, but gain by factor of 100
- Few events with 4 clusters + neutron { Fig. 4c}

VIII. Select Events within
Σ^- Missing Mass Window ($M_\Sigma \pm 36$ MeV)

Calculate Missing Mass off two π^o Invariant Mass
(MM should be from neutron + decay γ)

A. For K^- Beam Runs {Fig. 5a}

B. For π^- Beam Runs {Fig. 5b}

IX. K^- K^0 Charge Exchange

A. For K^- Beam Runs {Fig. 6a}

B. For π^- Beam Runs {Fig. 6b}
C. Missing Mass off Two π^- Invariant Mass{Fig. 7}

- K^0 peak present
- n present in Missing Mass
- Further Study needed

X. Conclusions

- K- reactions positively identified
- K^- p Signal Enhanced
  Using Cut On Number π^0's
- Cuts on Missing Mass Confirm Reactions
- π^- reaction "contamination" rejected by about
  a factor of 100

XI. Estimates of # K^- 's and Beam Rates

K^- = (# Detected Events) / [(Acceptance) (ρ L N_A) (σ)]

- ***Number Detected Events --***
  Detected Events are those with two π^0's
  Figure 3 (confirmed by Fig. 4)

- ***Acceptance***:
  (i) Assume isotropic π^0 distribution
  for Ballpark Estimate
  (ii) Cut on Solid Angle: $30^0 < \theta_{LAB} < 130^0$
  Gives factor of $(.75)^2$ for each π^0

- ***Cross Section***: $\sigma_\Lambda = 1.02$ mb (Reaction 1)
  $\sigma_\Sigma = 0.8$ mb (Reaction 2)

- Target Length L = 10 cm
- H *Density*: $\rho = .0708\ gm/cm^3$

Results for 4 runs (Set A):

For 30 Λ Events: **# K^- = 0.22 10^6**
For 32 Σ Events: **# K^- = 0.26 10^6**

Beam Rate = # K^- /Running Time

Run Time ~ 4 hr

Rate: 60 10^3 K^- /hr

Projection to 1998 $\gamma\Lambda$ Rates:

30 EVENTS/ 4 Hrs	**==>**	**10 Events/Hr of π Λ**
Improve by x30	**==>**	**300 Events/Hr of π Λ**
	or	3 **Events/Hr** $\gamma\Lambda$
		300 **Events/Wk** $\gamma\Lambda$

X. Conclusions For 1998 Data Taking Run

- • Mighty Few K^- 's in '97 Engineering Runs
- • Need Good K-Tune:

  Mysterious Log Book Notes on Magnet Trip
  & CTP Logical.

- •Must Budget Adequate Time
  to Do Quality Experiment